

Putting Effective Cost & Schedule Reserve Management into Practice with Earned Value Management

Project Management Challenge 2006
March 21, 2006

Dorothy Tiffany, CPA, PMP
NASA Goddard Space Flight Center

Walter Majerowicz, MBA, PMP
Computer Sciences Corporation

Future Challenges

“The Task Group also observes that resource constraints will likely pressure future programs, such as the Vision for Space Exploration. There will always be pressure for under-funding and overly-aggressive scheduling that must be recognized and mitigated by senior leadership.”

- Return to Flight Task Group Final Report, June 2005

How Important are Cost and Schedule?

“O.K., we’re lying about the cost and schedule, but otherwise some great things would not be built.”

- NASA Project Manager “X”
Feb 2005

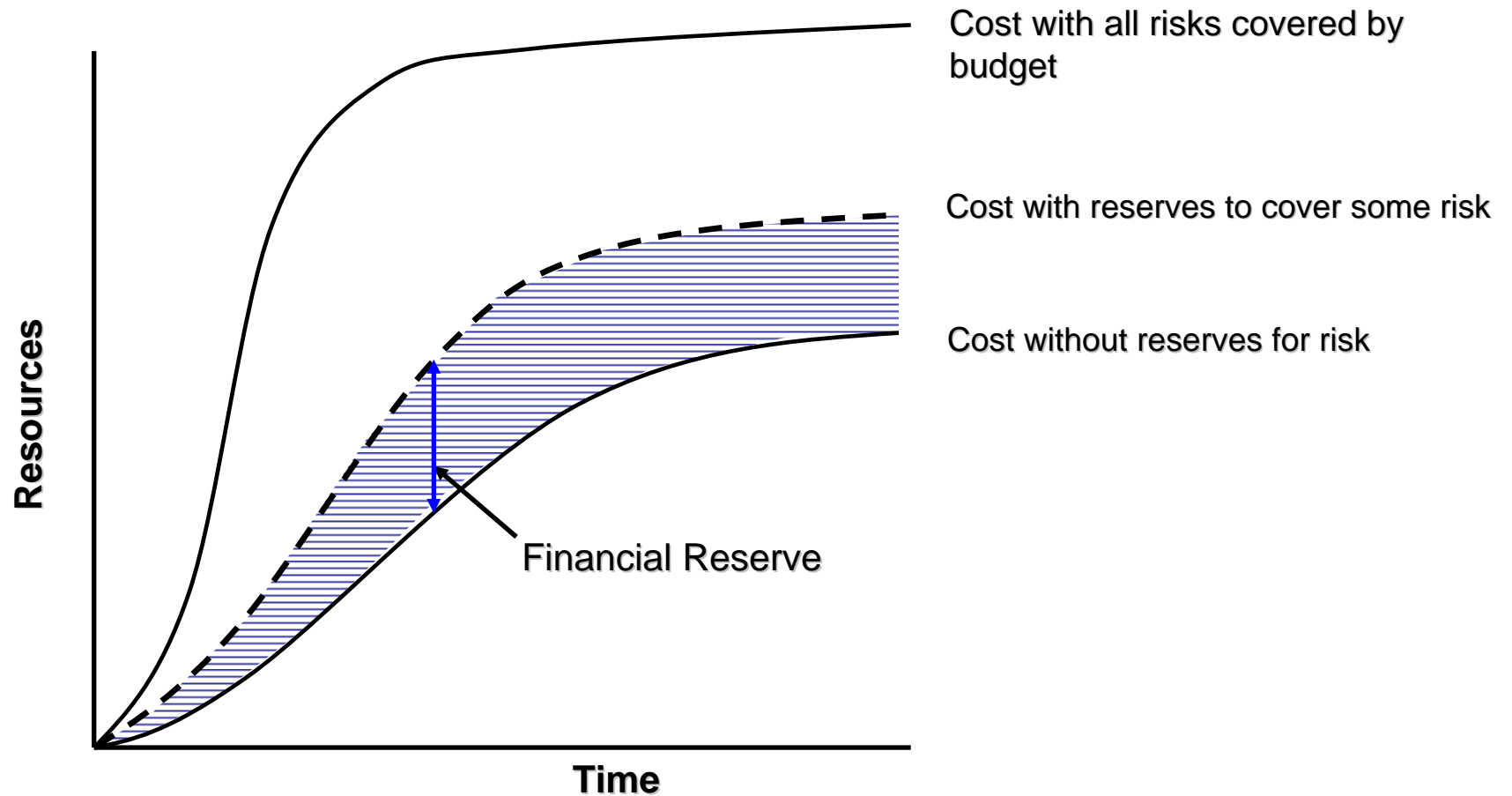
New Congressional Mandate

- Definitions
 - Development cost is from PDR to IOC (Phase C/D)
 - Life Cycle Cost is from PDR through end of Phase E
- Major program is one with a life cycle cost of > \$250M
- Congressional notification triggers
 - Development cost growth of 15% or...
 - 6 month slip in any major milestone
- Notification entails...
 - Magnitude of expected growth
 - Reasons for growth
 - Impacts to other programs/projects [siblings]
 - The revised cost and schedule if initial project requirements are held
 - The revised cost and schedule if remedial actions are taken [e.g. de-scopes]
 - An Analysis of Alternatives (AOA) with revised cost and schedule estimates
- Project termination required at 30% cost growth unless Congress authorizes continuation by law

Risky Business

- “Single point” cost and schedule estimates contribute to under-funded budgets and overly-aggressive schedules because they:
 - Assume the final outcome is known (e.g. “it will cost \$440M,” “it will take 56 months to finish”)
 - Do not fully consider risk (threats and opportunities) and other factors that could affect a project’s cost or schedule
 - Are one of many possible outcomes which can be less or more than the estimates
 - Have a near-zero percent probability of actually occurring as planned or budgeted
 - Often reflect bias of the estimator and can be overly optimistic or pessimistic
 - Tend to promote the “buy-in” syndrome which ultimately can lead to cost and schedule overruns

Risk Should Drive Reserve Levels



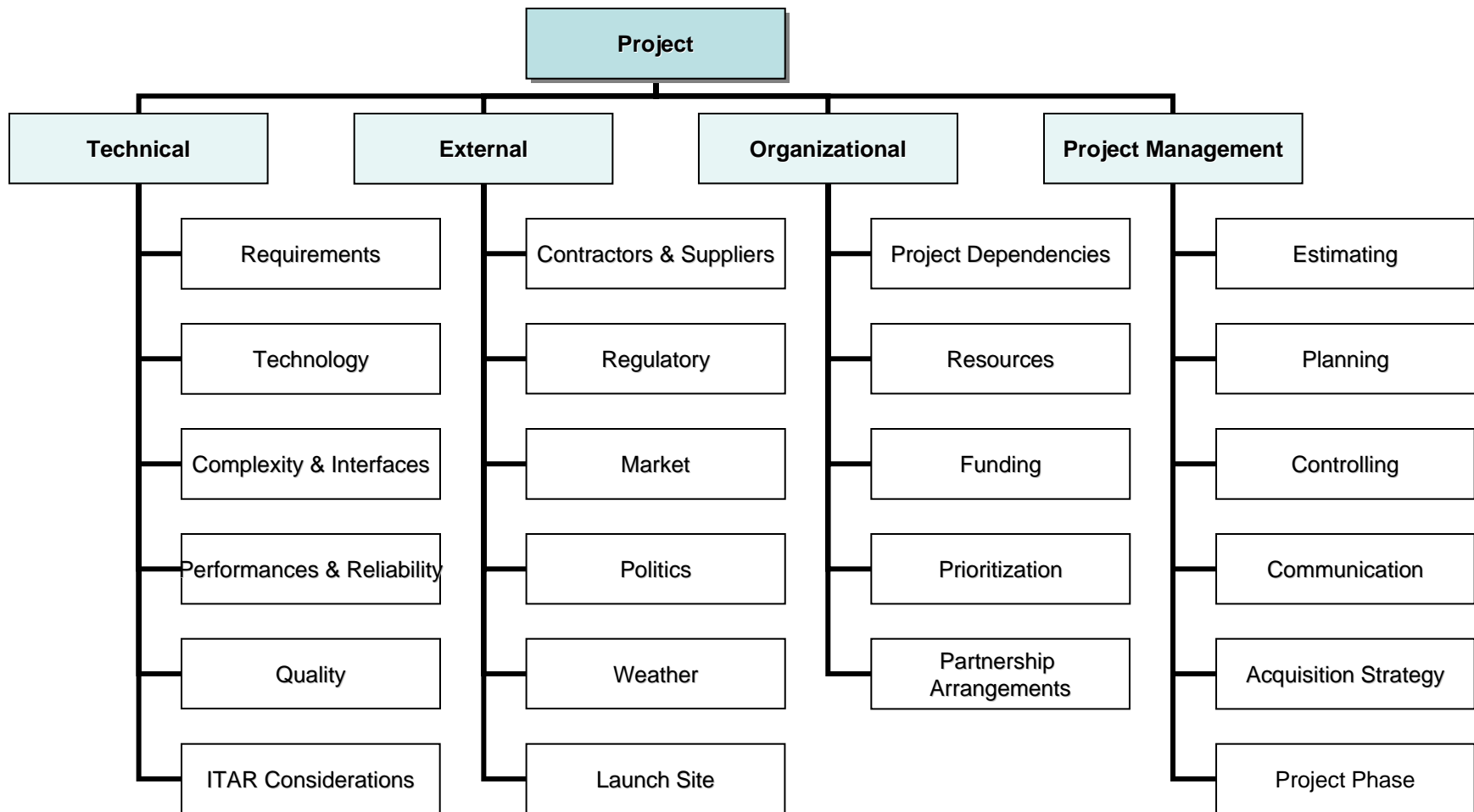
Range of Estimates

- Cost and schedule estimate “ranges” can help mitigate the threat of under-funded budgets and overly-aggressive schedules because:
 - A range of cost or duration estimates considers the risk inherent in the work scope
 - The probability of achieving outcomes within the range can be quantified
 - The estimate range provides a basis for establishing cost and schedule reserves
 - The range can be a key input to decision makers who must determine portfolio, program and project priorities

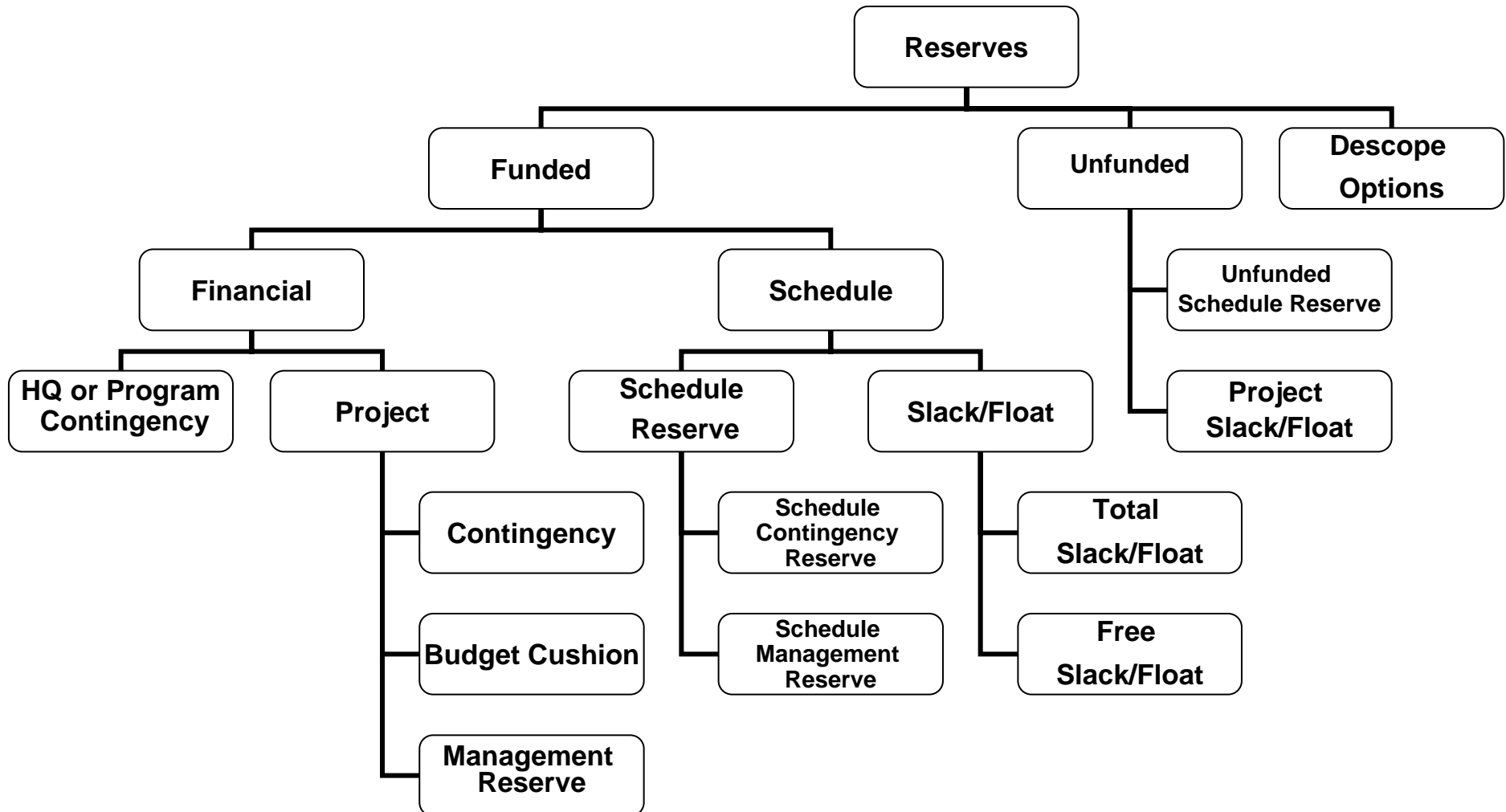
Understanding Risk Level Helps Determine Necessary Reserves

- How much new technology is involved in the development effort?
- Is this a new design?
- How much scope uncertainty is there?
- What is the heritage of this development?
- How aggressive is the schedule?
- How experienced is the management team?
- How stable is the organization?
- Are the resources (people, facilities) readily available?
- What is the basis for the cost and schedule estimate?
- What is the acquisition strategy?
- What types of contracts are involved?
- Are there environmental or facility issues?
- How will local, national or global politics impact the project?
- What is the labor and financial market status?
- Is the budget of partnering organizations stable?

Risk Breakdown Structure



Project Cost and Schedule Reserve Structure



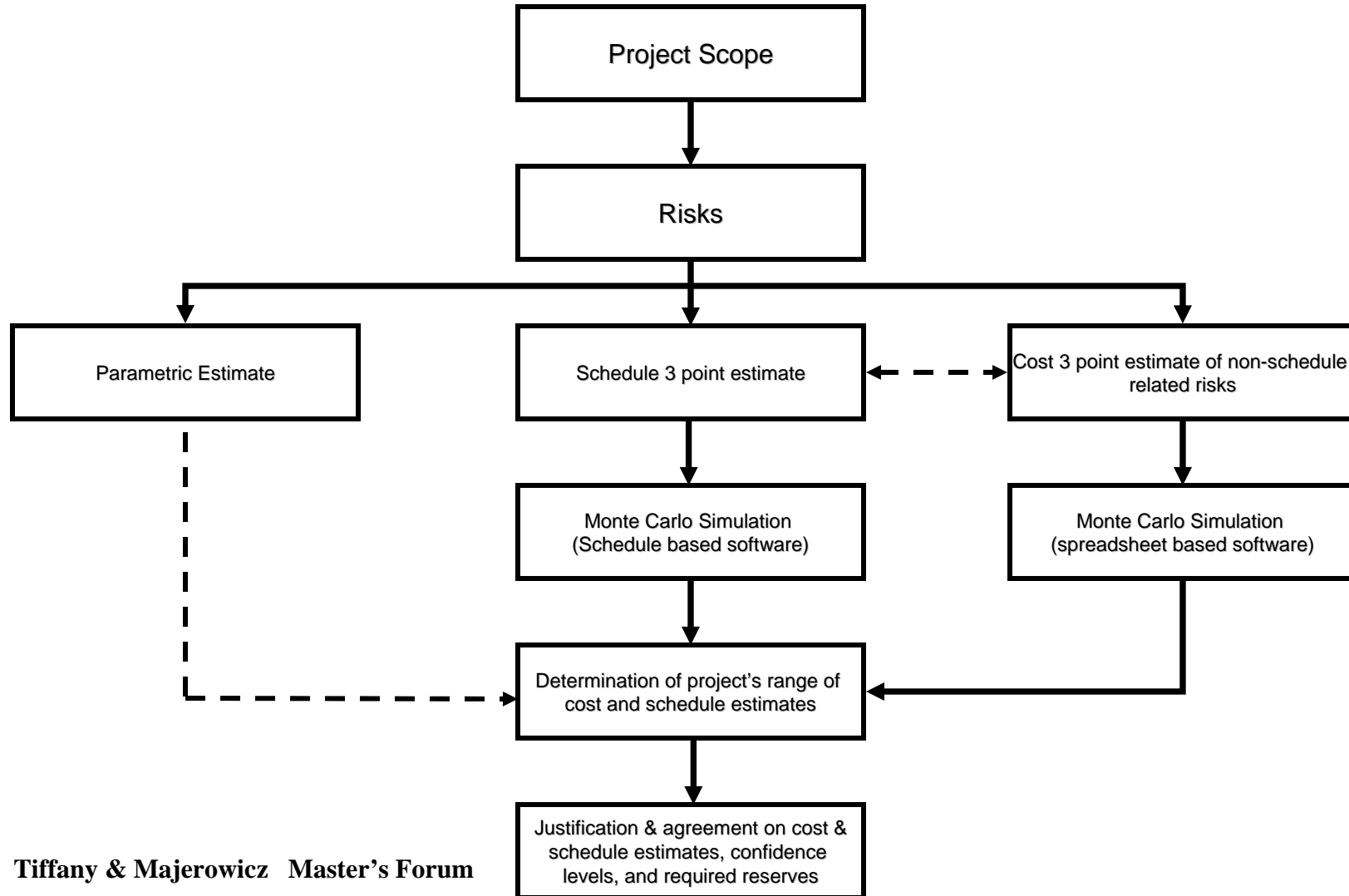
Reserve Planning Methods

<u>Planning Method</u>	<u>Approach</u>
Expert Judgment	Recommendation from those with expertise or experience appropriate for the application, discipline or effort
Applied Percentage	% of overall project duration (or budget) deducted OR added, and established as the schedule (or financial) reserve
Fixed Standard	Rule-of-thumb based on historic norms (e.g. one month of reserve for each year between time-now and launch readiness date)
Risk-Based Expected Value	Calculation of expected value of project risks (probability x impact)
Decision Tree Analysis	Determine reserve based on calculation of expected value of decision alternatives
3-Point Estimate Derivation	Evaluation of tradeoffs among most likely, optimistic, pessimistic and expected value activity durations (or budgets items)
Monte Carlo Analysis	Simulate the project schedule (or budget) by characterizing risk using 3-point estimates and specifying probability distribution shapes for activities (or budget items) to determine a range of possible outcomes and their associated confidence levels

Risk-Based Schedule Contingency Reserve

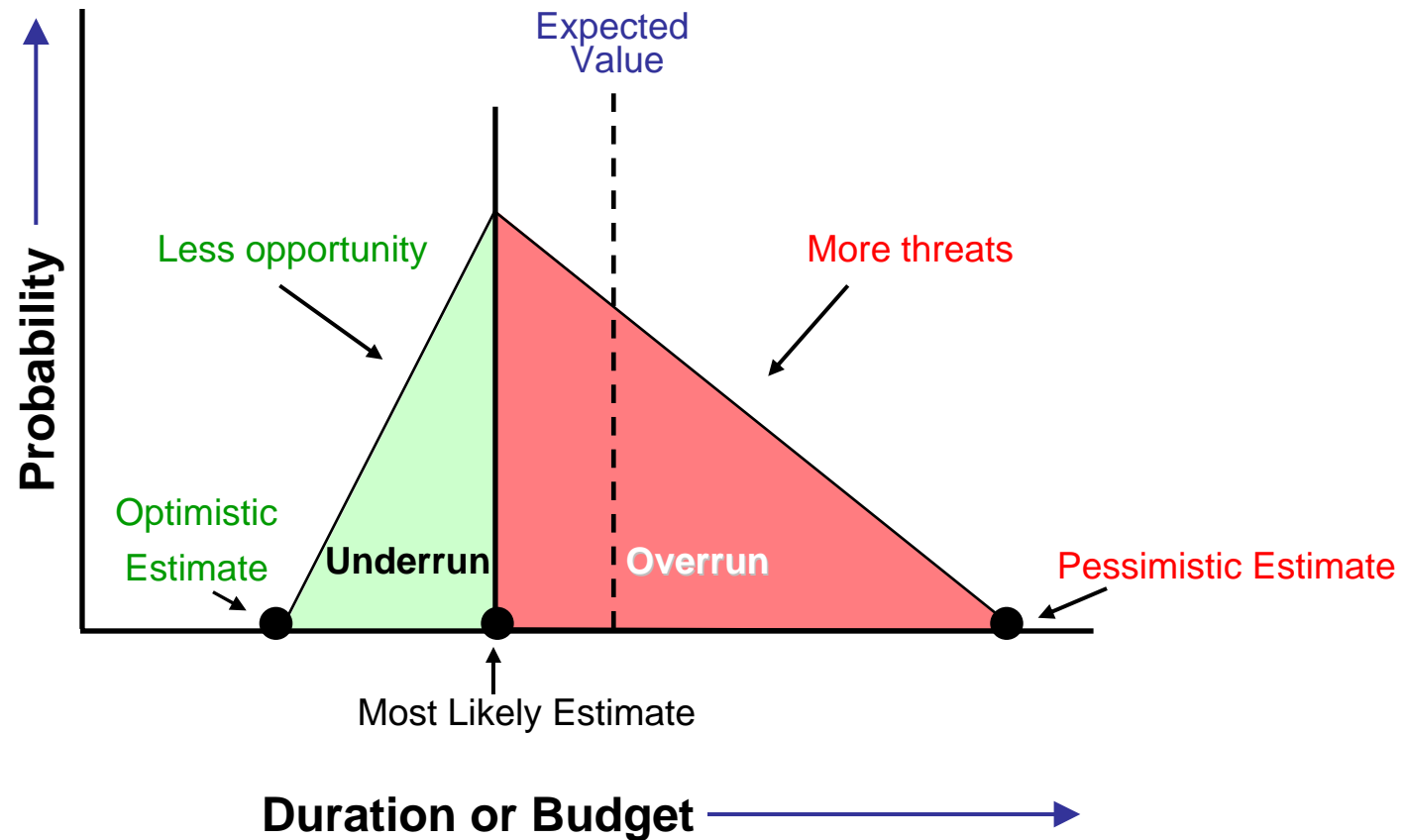
<u>Activity</u>	<u>Risk</u>	<u>Impact</u>	<u>Probability</u>	<u>Expected Value</u>
Observatory Mechanical Integration	Late MGSE	30 days	x .10 =	3 days
Observatory Vibration Test	Component damage	45 days	x .20 =	9 days
Observatory EMI Test	Noise anomaly	40 days	x .60 =	24 days
Thermal Vacuum Test	Instrument failure	80 days	x .50 =	<u>40</u> days
Total Reserve				76 days

Project Estimate Validation Process

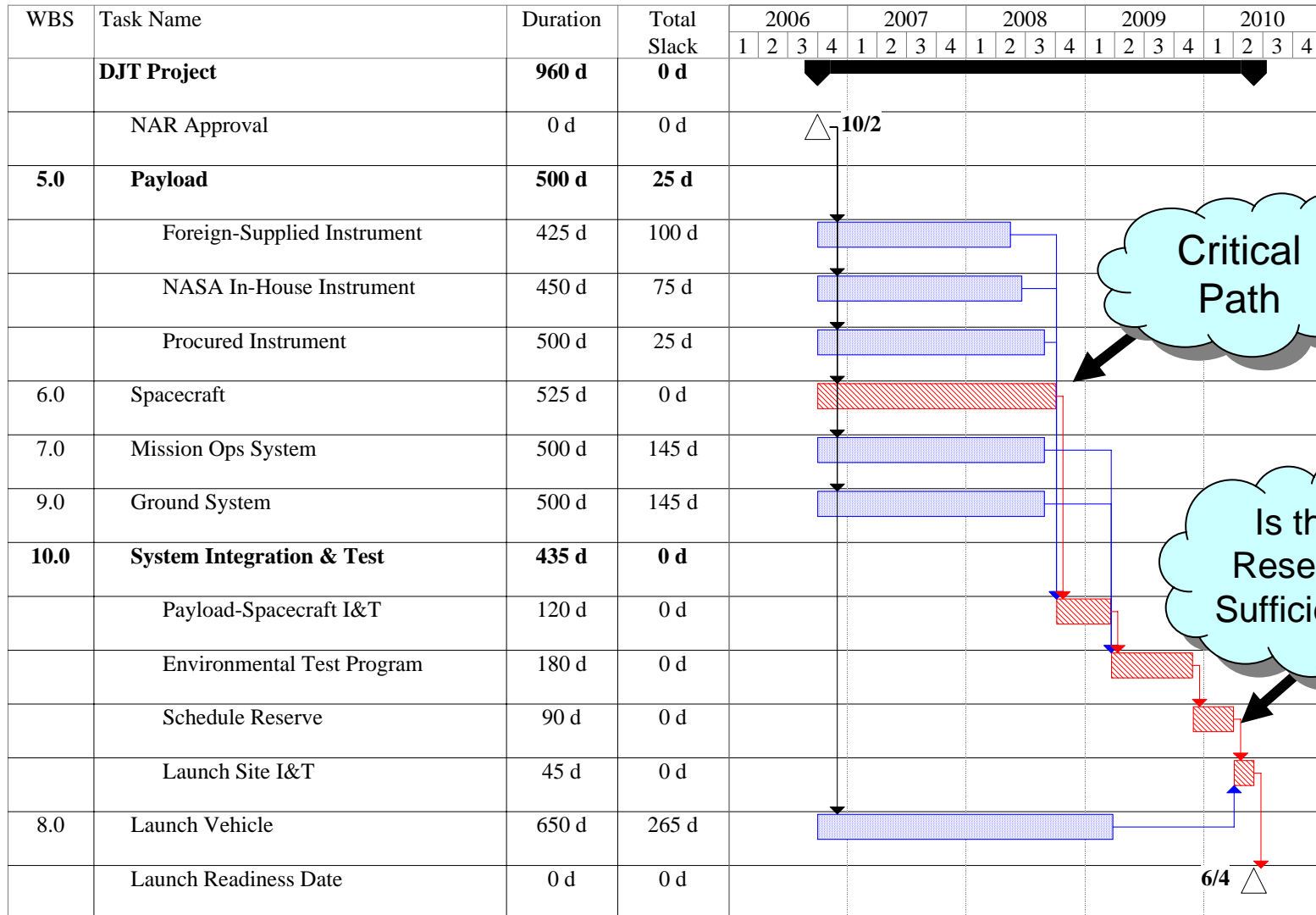


3-Point Estimate

$$\text{Expected Value} = \left[\frac{\text{Optimistic Estimate} + \text{Most Likely Estimate} + \text{Pessimistic Estimate}}{3} \right]$$



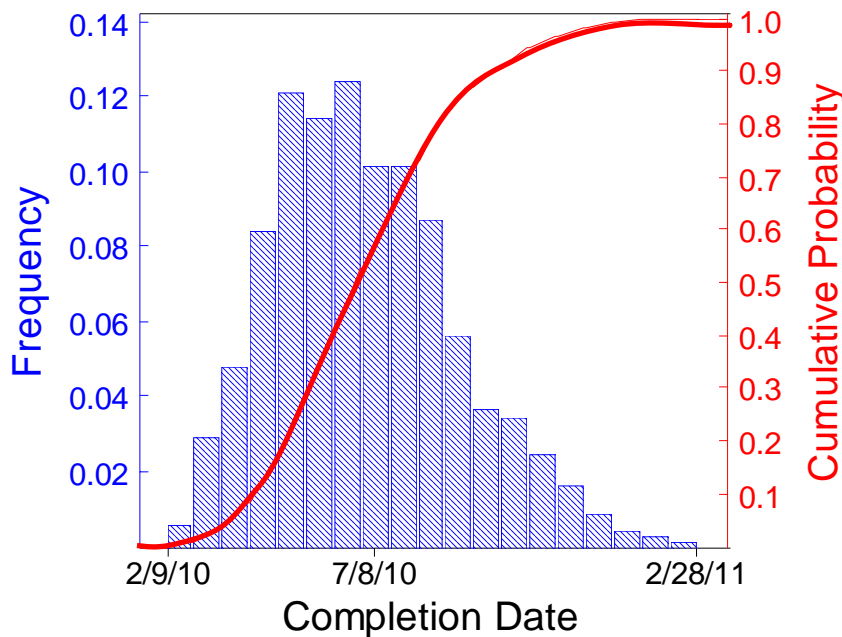
How confident are we of achieving a 6/4/10 launch?



Monte Carlo Analysis

Date: 1/2/2006 6:23:25 PM
Samples: 2500
Unique ID: 1
Name: DJT Project

Completion Std Deviation: 49.16 d
95% Confidence Interval: 1.93 d
Each bar represents 15 d



Completion Probability Table

<u>Prob</u>	<u>Date</u>	<u>Prob</u>	<u>Date</u>
0.05	3/31/10	0.55	7/8/10
0.10	4/16/10	0.60	7/20/10
0.15	4/29/10	0.65	7/29/10
0.20	5/7/10	0.70	8/10/10
0.25	5/18/10	0.75	8/20/10
0.30	5/26/10	0.80	9/2/10
0.35	6/4/10	0.85	9/20/10
0.40	6/14/10	0.90	10/13/10
0.45	6/22/10	0.95	11/15/10
0.50	7/1/10	1.00	2/28/11

The Project has a .35 Probability of Achieving a 6/4/10 Completion

Monte Carlo Schedule Simulation Demonstration



Calipso Monte Carlo Simulation Results (\$K)

Summary:

Entire range is from 183,042 to 264,412

Base case is 200,430

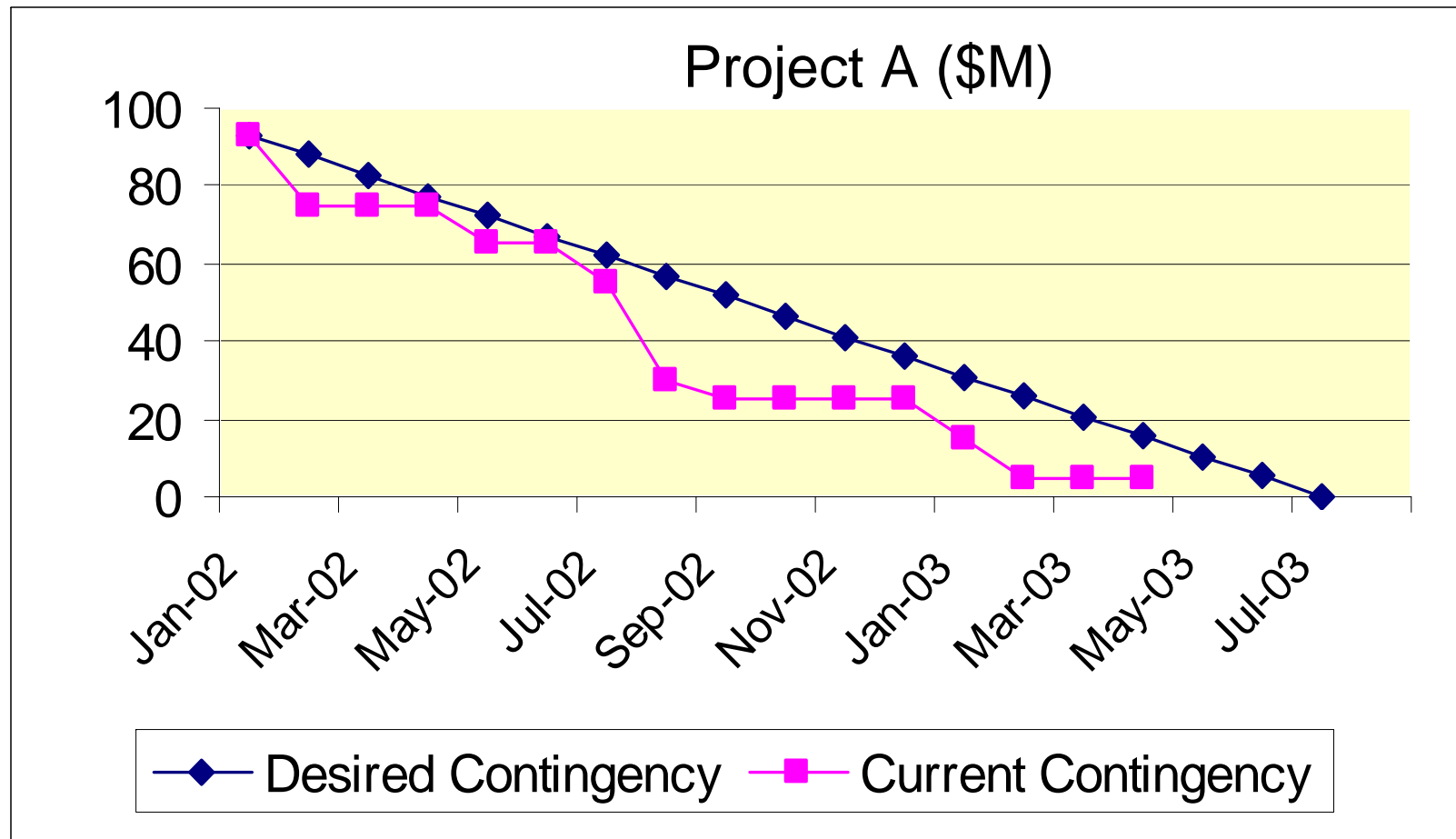
After 5,000 trials, the std. error of the mean is 200



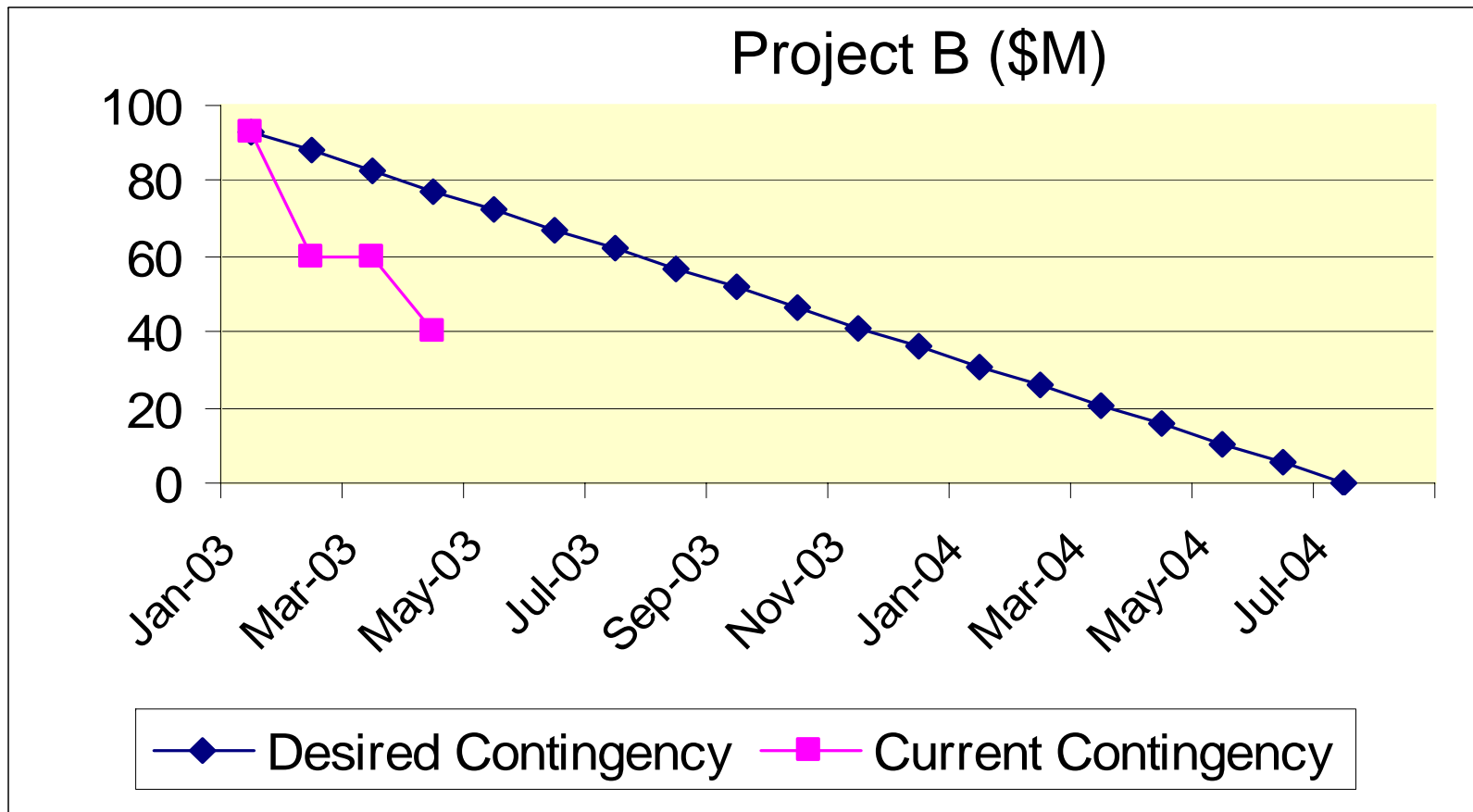
Forecast: Grand Total Cost and Schedule Delay Backup Data (\$K)

<u>Percentiles:</u>	<u>Forecast values</u>
0%	183,042
10%	199,554
20%	204,382
30%	208,354
40%	211,931
50%	215,667
60%	219,671
70%	224,714
80%	229,432
90%	236,819
100%	264,412

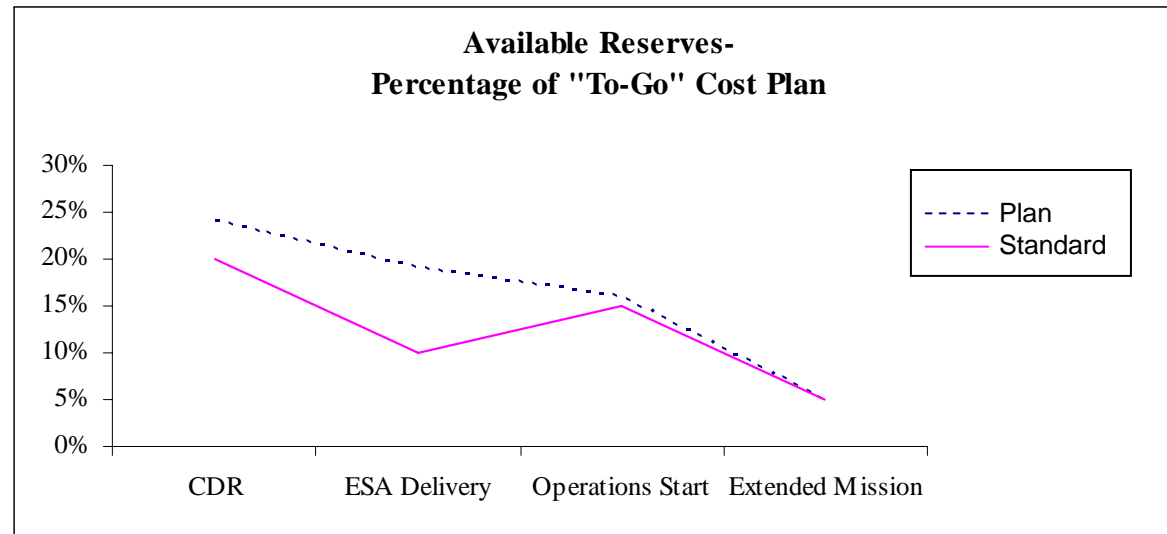
Contingency Trend Analysis



Contingency Trend Analysis

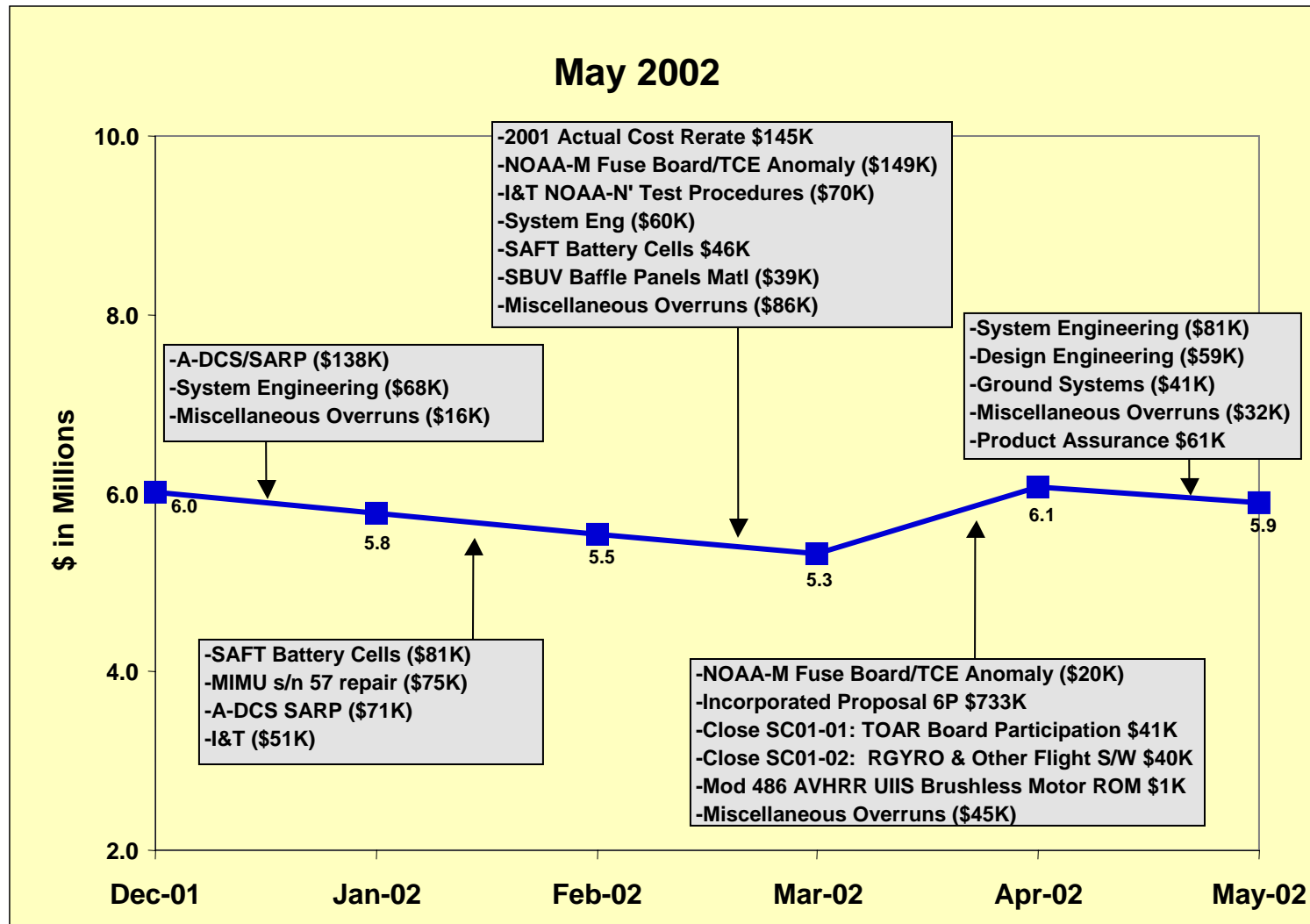


Establishing Thresholds

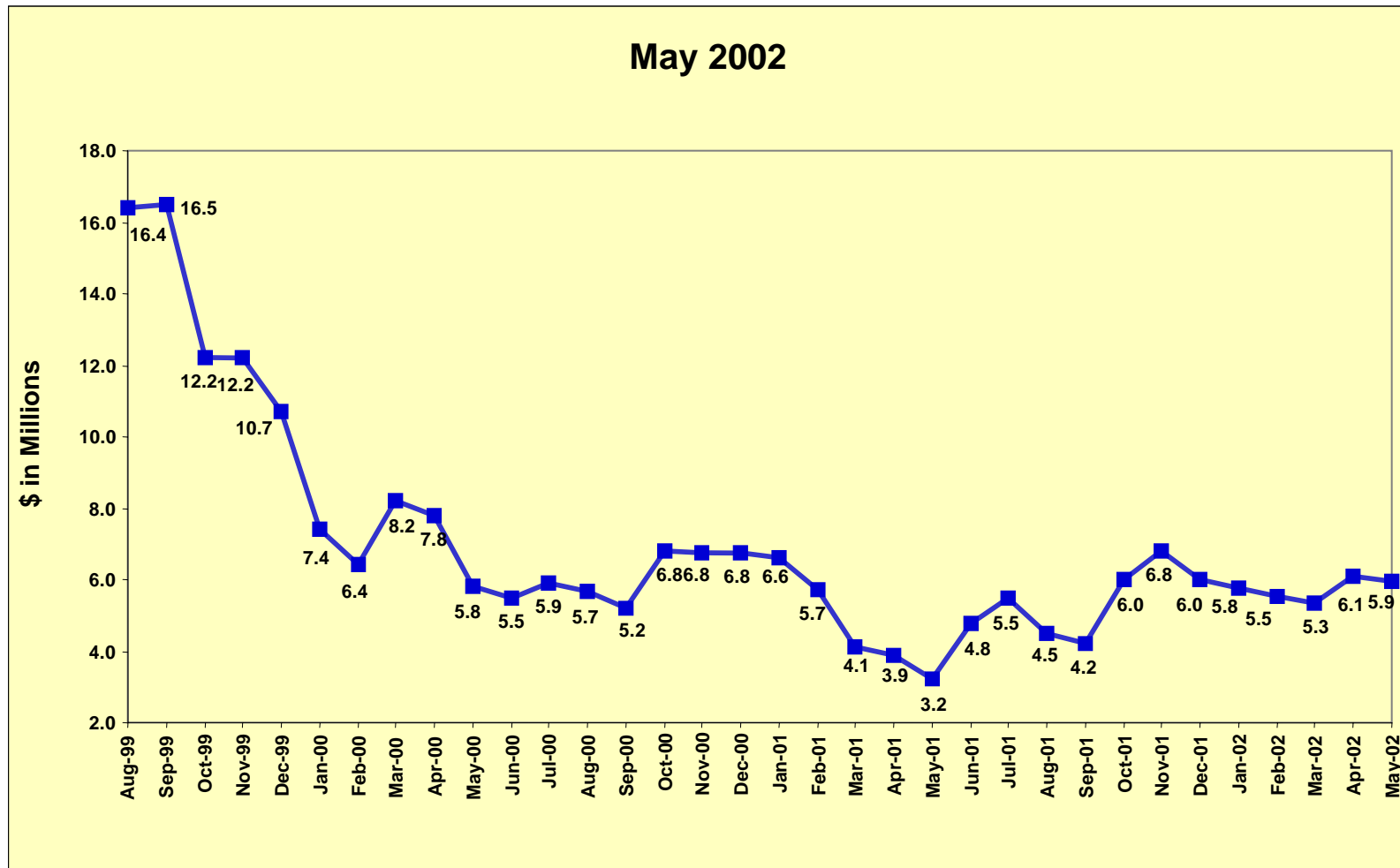


(\$ in 000s)		Beginning		ESA				
		Balance		Delivery		Operations		Ext Mission
	<u>Reserve: Project Cost</u>	<u>CDR (Oct 05)</u>		<u>June FY06</u>		<u>Start 6/FY08</u>		<u>Aug FY09</u>
	Available Reserve	\$ 8,500		\$ 1,000		\$ 210		\$ 12
	Available Cost (To-Go)	\$ 35,169		\$ 5,399		\$ 1,352		\$ 249
	Ratio	24%		19%		16%		5%
	Standard	20%		10%		15%		5%
	Over/ (Under) Standard	4%		9%		1%		0%

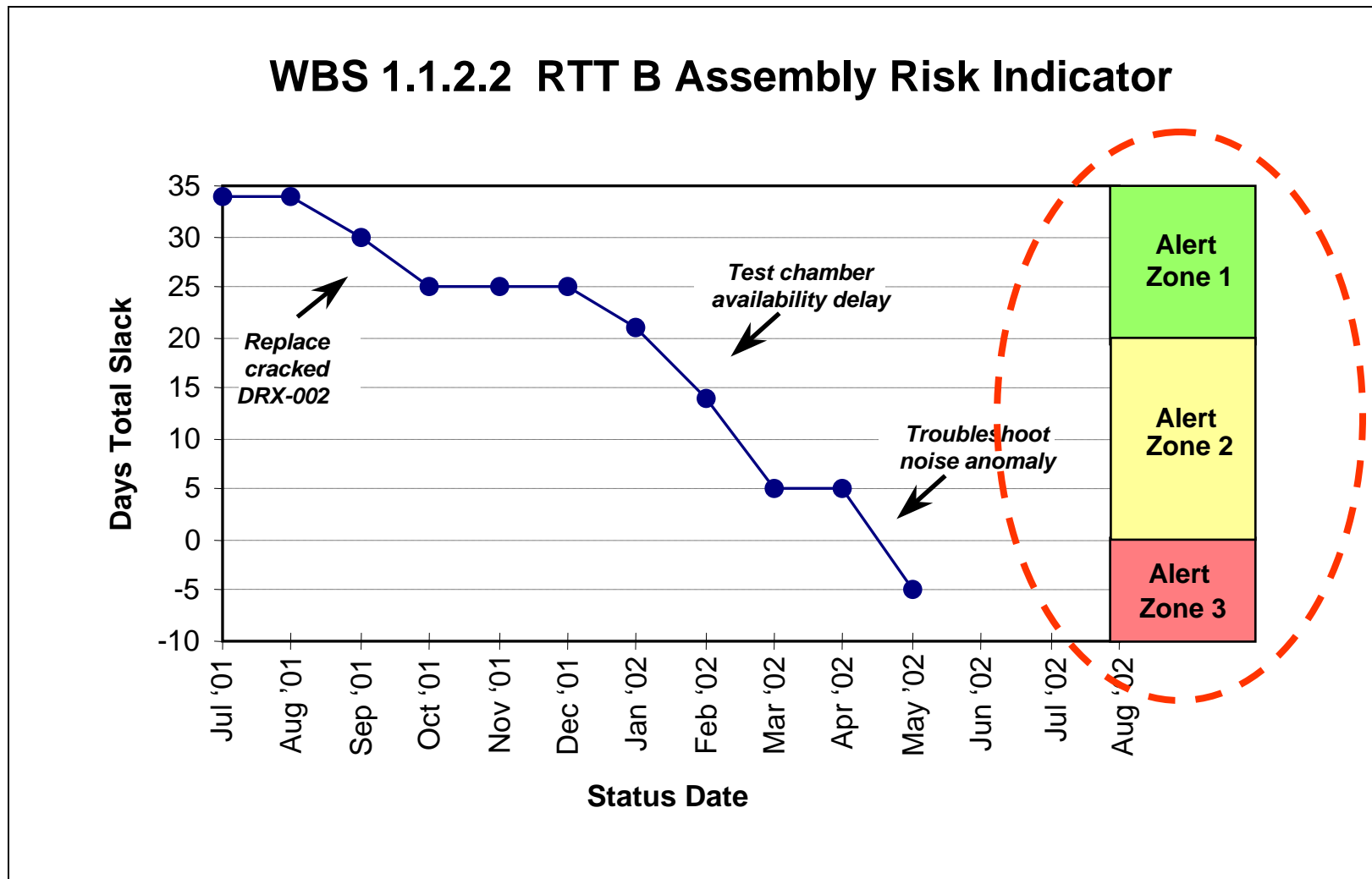
Contingency Reserve History



Contingency Reserve History



Example Slack Trend With Risk Thresholds



Top Payload Critical Paths

10/30/02

System	Subsystem	Critical Component	Slack * to Payload Delivery	Slack * to Launch	Comment
Lidar	ILT	RADLOM I&T	0 Days (TBD)	0 + 60 Days	BEO issue
Lidar	ILR	PMT Modules	0 Days	0+ 60 Days	LaRC Activity
Flight IIR (GFE)			0* Days	0 + 60 Days	
Lidar	ILT	Lidar Core I&T	1 Days	1 + 60 Days	
Lidar	ILR	Shutter Mechanism	8 Days	8 + 60 Days	
Lidar		Payload Controller	13 Days	13 + 60 Days	SIB Problem
Lidar	ILT	Wide Field Camera	35 Days	35 + 60 Days	
Lidar	ILT	Laser Electronics Module (Fibertek)	38 Days	38 + 60 Days	

• Slack shown in work days

*Slack to delivery date on this row is calculated from optimal integrated date.

Summary

- Managing reserves is often misunderstood and under managed
- Quantitatively linking reserve levels to risk threats and opportunities provides excellent justification for reserve requests
- Reserve usage control and tracking improves the decision making process

Dorothy Tiffany

Program Business Manager
NASA Goddard Space Flight Center
Dorothy.J.Tiffany@nasa.gov
301-286-5917

Walt Majerowicz

Senior Manager-NASA Programs
Computer Sciences Corporation
Walter.Majerowicz.1@gsfc.nasa.gov
301-286-5622